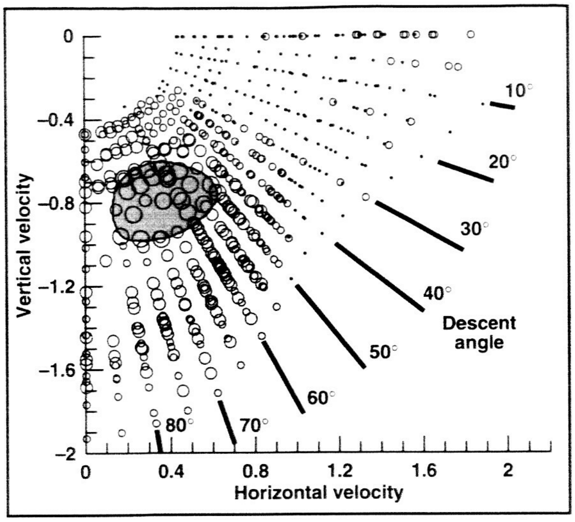

Fig. 2. Oscillatory rotor thrust magnitudes.

could cause low-frequency thrust and roll fluctuations in tilt-rotor aircraft operating in VRS.

Although these characteristics are generally similar to those of helicopter rotors, the data indicate that tilt rotors may experience larger thrust reductions and greater thrust fluctuations than single helicopter rotors. Because the image plane may not accurately represent the effects of a second rotor, further research is required to determine these characteristics for two side-by-side rotors.

Point of Contact: Mark Betzina
(650) 604-5106
mbetzina@mail.arc.nasa.gov

A Comparison of Transmission Vibration Responses from OH-58C and AH-1 Helicopters

Edward M. Huff, Irem Y. Tumer, Marianne Mosher

As part of NASA's overall goal to improve aviation safety, fundamental research is being conducted to support the development of systems that monitor critical rotating components, such as those found in helicopter gearboxes and aircraft engines. Damage detection based on observed patterns of surface vibration requires insight into the statistical properties of complex signals that are produced by interacting elements within the system, as well as the effects of in-flight maneuvering.

Table 1 shows the tendency of vibration signals to remain constant (i.e., stationary) over 34-second recording intervals. The extent of nonstationarity is dependent on both maneuver state and aircraft type, which other evidence suggests are related to vehicle weight and engine torque variations. Hence, these findings provide an essential link for developing damage-detection algorithms that are not deceived by nonstationarity into making costly "false-alarms."

In FY2000 we conducted the first flight tests of the Ames' OH-58C aircraft and made comparisons of vibratory signals with an identical transmission tested at the NASA Glenn Helicopter Transmission Facility. Table 2 shows the results of an effort to parse signal energy for transmission component sources from these two tests. This work reveals similarities and differences between real flight and test rig vibration signals, information that is necessary to develop damage-detection algorithms with low false-alarm rates and high fault detection. Work in this area was reported at the American Helicopter Society Annual National Forum in 2000.

Point of Contact: Edward Huff
(650) 604-4870
ehuff@mail.arc.nasa.gov

Table 1. Stationarity for OH-58 and AH-1

Maneuver	Stationary Records, percent	
	OH-58 Kiowa	AH-1 Cobra
A. Forward flight, low speed	70.8	55.6
B. Forward flight, high speed	65.3	61.1
C. Sideward flight left	12.5	22.2
D. Sideward flight right	9.7	31.9
E. Forward climb, low power	50.0	97.0
F. Forward descent, low power	16.7	68.1
H. Hover	30.2	80.2
I. Hover turn left	11.1	59.7
J. Hover turn right	15.3	36.1
K. Coordinated turn left	79.2	80.6
L. Coordinated turn right	83.3	80.6
M. Forward climb, high power	65.3	86.1
N. Forward descent, high power	22.2	72.2
Average stationarity	40.6	64.2

Table 2. OH-58C and Test Rig Spectral Variance Components

	OH-58c Aircraft Average 4 Radial Channels			OH-58c Test Rig Sensor #3 Radial		
Source	**Variance MS**	**df**	**Percent Total MS**	**Variance MS**	**df**	**Percent Total MS**
Planetary	17.98	70	17.48	23.38	70	13.79
Pinion - gear	15.86	18	15.42	30.14	18	17.77
Engine	22.29	6	21.68			
Residual Variance	46.70	8098	45.42	116.07	8104	68.44
Total Mean Square (MS)	102.83	8192	100.00	169.59	8192	100.00